10/809,918

COFC

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:
Christophe MALEVILLE et al.

Confirmation No.: 6754

Patent No.: 6,833,314 B2

Application No.: 10/809,918

Patent Date: December 21, 2004

Filing Date: March 26, 2004

For: METHOD OF CHARACTERIZING IMPLANTATION OF A SPECIES IN A SUBSTRATE BY SURFACE IMAGING

Attorney Docket No.: 4717-13300

REQUEST FOR CERTIFICATE OF CORRECTION UNDER 37 C.F.R. § 1.322

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Sir:

Patentees hereby respectfully request the issuance of a Certificate of Correction in connection with the above-identified patent. The corrections are listed on the attached Form PTO-1050, submitted in duplicate. The corrections requested are as follows:

Title Page:

Item (56) **References Cited**, OTHER PUBLICATIONS:

Shiettekatte et al. reference, delete "Shiettekatte" and insert -- Schiettekatte --; after "temperature influence", insert -- on --; and after "extended defects", delete "nucleanon" and insert -- nucleation --.

L.J. Huang et al. reference, after "Model for blistering", insert -- and splitting --.

Bruel et al. reference, after "Nuclear", delete "instrument" and insert -- instruments --.

Lanzieri et al. reference, delete "semi-insulatiing Gaas" and insert -- semi-insulating GaAs --.

The above changes are made merely to correct inadvertent clerical and typographical errors.

Please insert the following reference:

-- da Silva et al., "The effects of implantation temperature on He bubble formation in silicon," Nuclear Instruments and Methods in Physics Research Section B: Beam Interactions with Materials and Atoms, Vols. 175-177, pp. 335-339 (April 2001). --.

Applicants note that the da Silva et al. reference was listed on the Form PTO-1449 submitted with the Information Disclosure Statement filed September 16, 2004. The reference is believed to have been considered by the Examiner, as the Examiner did not draw a line through the citation on the Form PTO-1449, as would be required by MPEP § 609(C)(1) and (C)(2). As no notation was made in the Notice of Allowance that returned the Form PTO-1449, it is believed that the Examiner's failure to initial this citation was purely an oversight. Therefore, it is respectfully requested that this reference be incorporated by way of certificate of correction.

Item (57) **ABSTRACT**, line 5, after "implanted atomic species to", delete "from" and insert -- form --. This change is requested merely to correct an inadvertent typographical error and does not involve the introduction of new matter.

Column 9:

Line 55 (claim 1, line 6), before "blisters in a surface region", delete "from" and insert -- form --. This change is requested merely to correct an inadvertent typographical error and does not involve the introduction of new matter.

Column 10:

Line 53 (claim 17, line 2), after "that is implanted comprises hydrogen", delete "of" and insert -- or --. Support for this change can be found in application claim 17.

A fee of $100 is believed to be due for this request. Please charge the required fees to Winston & Strawn LLP Deposit Account No. 50-1814. Please issue a Certificate of Correction in due course.

Respectfully submitted,

1/6/05
Date

Allan A. Fanucci, Reg. No. 30,256

WINSTON & STRAWN LLP
Customer No. 28765

212-294-3311

JAN 13 2005

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO.: 6,833,314 B2
DATED: December 21, 2004
INVENTORS: Maleville et al.

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(12) **United States Patent**
Maleville et al.

(10) **Patent No.: US 6,833,314 B2**
(45) **Date of Patent: Dec. 21, 2004**

(54) **METHOD OF CHARACTERIZING IMPLANTATION OF A SPECIES IN A SUBSTRATE BY SURFACE IMAGING**

(75) Inventors: **Christophe Maleville**, La Terrasse (FR); **Walter Schwarzenbach**, Saint-Nazaire-les-Eymes (FR)

(73) Assignee: **S.O.I.Tec Silicon on Insulator Technologies S.A.**, Bernin (FR)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **10/809,918**

(22) Filed: **Mar. 26, 2004**

(65) **Prior Publication Data**

US 2004/0209449 A1 Oct. 21, 2004

Related U.S. Application Data

(63) Continuation of application No. PCT/FR02/03281, filed on Sep. 26, 2002.

(30) **Foreign Application Priority Data**

Sep. 28, 2001 (FR) 01 12507

(51) **Int. Cl.**[7] **H01L 21/425**
(52) **U.S. Cl.** **438/530**; 438/514
(58) **Field of Search** 438/530, 510, 438/514, 515, 517, 518, 522

(56) **References Cited**

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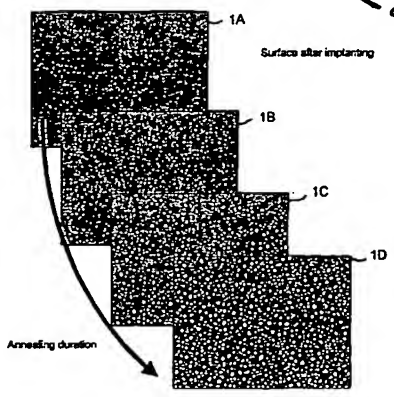
Primary Examiner—Michael S. Lebentritt
Assistant Examiner—Beth E. Owens
(74) *Attorney, Agent, or Firm*—Winston & Strawn LLP

(57) **ABSTRACT**

A method for characterizing a dose or dosage of implanted atomic species in a substrate by annealing the substrate after implantation of the atomic species, with the anneal conducted at a temperature and for a time sufficient to cause the implanted atomic species to from blisters in a surface region of the substrate but below that which would cause a majority or significant amount of the blisters to burst; imaging the surface region of the substrate to obtain a surface image; and processing the surface image to characterize the implant dose of the atomic species. This characterization can be performed on a qualitative or quantitative basis, as desired.

20 Claims, 2 Drawing Sheets



da Silva et al., "The effects of implantation temperature on the bubble formation in silicon," Nuclear Instruments and Methods in Physics Research Section B: Beam Interactions with Materials and Atoms, Vols. 175-177, pp 335-339 (April 2001).

an implanted substrate (these observations generally being performed through, the thickness of the substrate).

FIG. 4 shows another way of using the measured density parameter for the purpose of characterizing the uniformity of the dose implanted over the surface of a substrate. This application can be combined with the dispositions described above. FIG. 4 shows a measurement of the dose as really implanted—and as measured using the invention as described above—all around a substrate. It shows up under-implantation in the 12 o'clock to 2 o'clock sector. This measurement is a function of the heat budget as locally absorbed by the substrate during annealing. It therefore depends on temperature uniformity within the annealing oven.

To compensate for possible lack of temperature uniformity in the annealing oven, it is possible to cause the substrate to revolve during annealing. It is also possible to perform annealing on a plurality of identical substrates that have been implanted under the same conditions and in the same implanter (or by implanters that have been suitably compensated relative to one another, see above). Under such circumstances, where annealing is performed on a plurality of identical substrates, each substrate is given a different orientation in the annealing oven so as to overcome local temperature effects.

For example, in order to overcome the ortho-radial effect shown up by FIG. 4, the substrates should be disposed with angular orientations that are regularly distributed over the range 0° to 360°. The measurements performed on identical substrates that have been oriented differently in the annealing oven are then averaged. In general, when observing an individual measurement of spatial distribution of dose that reveals a local anomaly, it is appropriate to determine whether the anomaly is due to the annealing by suitably distributing identical substrates in a given oven so as to overcome local temperature effects, and then by averaging the measurements over the substrates. Once such techniques have been applied to obviate local effects in annealing ovens, it is possible to obtain an overall view of doses as implanted over the area of a substrate and thus to characterize uniformity of implantation.

The invention thus provides a method that is simple and inexpensive for characterizing implantation (annealing time, image acquisition, plus analysis by image processing together requiring less than 2 hours). Also, the invention does not require specialist equipment and it can be applied without specific adaptations on any type of implanted substrate.

What is claimed is:

1. A method for characterizing a dose of implanted atomic species in a substrate, which comprises:

annealing the substrate after implantation of the atomic species, with the anneal conducted at a temperature and for a time sufficient to cause the implanted atomic species to from blisters in a surface region of the substrate but below that which would cause a number the blisters to burst;

imaging the surface region of the substrate to obtain a surface image; and

processing the surface image to determine the characteristics of the implanted dose of the atomic species.

2. The method of claim 1, wherein the characteristics of the implanted dose of the atomic species are quantitative characteristics.

3. The method of claim 2, wherein the surface image is observed to determine density or size of the blisters, or both density and size.

4. The method of claim 2, wherein the surface image is obtained by a charge coupled device and the implant dose is characterized by a density parameter.

5. The method of claim 2, wherein the surface image is observed to determine blister area.

6. The method of claim 1, wherein the blister density is calibrated as a function of implantation dose prior to annealing.

7. The method of claim 6, which further comprises calculating the implantation dose of atomic species by comparing the processed surface image to images of known implanted doses of atomic species.

8. The method of claim 1, which further comprises establishing compensation factors for implantation dose measurements by comparison of the processed image to reference implantation data.

9. The method of claim 8, wherein a compensation factor is applied to an implanter to obtain improvements in subsequent implanted doses.

10. The method of claim 8, wherein a compensation factor is determined by balancing implantation operations performed by different implanters that are used to implant the atomic species.

11. The method of claim 1, wherein the characteristics of the implanted dose of the atomic species are qualitative characteristics.

12. The method of claim 1, which further comprises analyzing spatial distribution of the blisters from the processed image to determine uniformity of implantation of the atomic species.

13. The method of claim 1, which further comprises performing blister measurements on different locations of the substrate surface so as to obtain a spatial distribution of the dose over the surface of the substrate.

14. The method of claim 1, which further comprises performing blister measurements on a plurality of substrates which have been annealed under the same conditions but with different orientations in order to determine local temperature effects.

15. The method of claim 1, wherein the processed image is observed to characterize the uniformity or thickness of the implanted dose of atomic species.

16. The method of claim 14, wherein the uniformity is determined by establishing regions of the substrate that have received a dose of atomic species per unit area that differ from a mean dose of atomic species that is received by the substrate.

17. The method of claim 1, wherein the atomic species that is implanted comprises hydrogen of helium and the implantation is conducted at a dose of greater than 10^{16} atoms per square centimeter.

18. The method of claim 1, wherein the annealing is conducted for a time of between about 5 to 20 minutes at a temperature of between 300 and 550° C.

19. The method of claim 1, wherein the substrate comprises a semiconductor material.

20. The method of claim 19, wherein the semiconductor material is a silicon single crystal.

* * * * *

Day : Thursday
Date: 1/13/2005

Time: 12:37:09

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Correspondence Address for 10/809918

Customer Number	Contact Information	Address
28765	Telephone: (202)371-5904 Fax: No Fax # E-Mail: No E-Mail Address	WINSTON & STRAWN PATENT DEPARTMENT 1400 L STREET, N.W. WASHINGTON DC 20005-3502

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